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The Importance of Technology in an Economic Recovery

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Chairwoman Velázquez, Ranking Member Graves, and Members of the Committee, thank you for the opportunity to testify today regarding the Small Business Innovation Research (SBIR) program at the National Science Foundation (NSF). From its earliest days, NSF has been tasked "To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense." The SBIR program at NSF serves all these goals.

I will focus my remarks on two main areas: ensuring the benefits of technological innovation, and the impact of NSF SBIR funding on the growth of small businesses, including the growth of employment in these firms. But first I feel that I should provide you with a brief outline of the history of the SBIR program at NSF.

History of the NSF-SBIR Program

In 1977 the National Science Foundation (NSF) initiated a pilot program called the "Small Business Innovation Research" (SBIR) program. This program solicited research proposals from profit-seeking small firms. Subsequently in 1982, Congress established the SBIR program in order to provide increased opportunities for small businesses to:

- meet federal research and development needs,
- stimulate technological innovation,
- foster and encourage participation in technological innovation by socially and economically disadvantaged persons,
- increase private-sector commercialization of innovations derived from federal research and development.

The primary objective of the NSF-SBIR program is to increase incentives and opportunities for small firms to undertake cutting-edge, high-risk, high-quality, scientific, engineering, and science-education research that has the potential for economic payoff if the innovation is successful. Additionally, the program seeks to stimulate technological innovation in the private sector, increase commercial application of NSF-supported research, and improve the return on our investment in Federally funded research for its economic and social benefits to the nation.

It is important to note that NSF is not a "mission agency" and our SBIR program is not focused on developing applications for NSF's own use. Instead we are focused on ensuring that innovative technologies and products based on those technologies make it to the market to benefit the American people.

Overview of the SBIR program at NSF

The SBIR program at NSF is managed within the Division of Industrial Innovation and Partnerships in the Directorate for Engineering. In addition to the SBIR program, the division manages several university-industry partnership programs: Small Business Technology Transfer, Industry/University Cooperative Research Centers, Partnerships for Innovation, and Grant Opportunities for Academic Liaison with Industry. This testimony will primarily address the SBIR program. The FY2008 allocation for SBIR at NSF was $95.5 million and 305 new awards were made. With the anticipated $50 million additional FY2009 funding through the American Recovery and Reinvestment Act, we plan to substantially increase the number of awards to small businesses this year.

The program funds firms innovating in a wide spectrum of technologies including agriculture, biotechnology, medical applications, materials, manufacturing, energy, environment, electronics, information technology and nanotechnology. NSF is currently soliciting new proposals in four broad areas:

- Biotechnology and Chemical Technologies,
- Education Applications,
- Information and Communication Technologies, and
- Nanotechnology, Advanced Materials and Manufacturing.

At NSF, SBIR grants are divided into two competitive phases. Phase I awards have a duration of six months and were recently raised to a maximum of $150,000. These awards provide support to conduct feasibility research into new techniques or products. All Phase I awardees subsequently are eligible to apply for a Phase II award which can be for up to $500,000 and two years in duration.

NSF actively supports the SBIR program goal to increase private sector commercialization. To do this, we have designed several supplements to further the commercial success of our awardees. The flagship amongst these is the Phase IIB supplement. Supplements are also available to provide additional support for college and high school students, and for teachers to participate in research with SBIR awardees; to form partnerships with minority-serving universities, colleges, and community colleges; to help firms form partnerships with NSF-funded research centers, and to provide mentoring to other NSF-funded SBIR firms. These NSF SBIR supplemental funding opportunities are listed in the appendices and therefore I will only touch on a few of them that are unique to NSF.

In 1998, NSF introduced the Phase IIB supplemental grant opportunity for its Phase II grants. The Phase IIB helps bridge the gap in funding between Phase II and ultimate commercialization. The Phase IIB provides additional funds to Phase II awardees who

obtain third party funds. The objective of the Phase IIB is to extend the R&D efforts beyond a current grant to meet the product, process, or software requirements of a third party investor to accelerate the Phase II project to the commercialization stage and/or enhance the overall strength of the commercial potential of the Phase II project. A Phase IIB Supplement up to $250,000 extends the Phase II grant for one year while a Phase IIB supplement in excess of $250,000 extends the Phase II grant for two years; the size of a Phase IIB award is determined by the amount of third-party investment the grantee has secured. We have found that awardees that are able to secure the outside funding to qualify for Phase IIB have had better success in commercializing their innovations. After five years, about 69% of firms that received Phase IIB funding were beginning to see success, whereas only 31% of those not having a IIB supplement were successful. Many of the Phase IIB firms have grown in both revenue and employment and some have been acquired by larger firms.

Phase IIB External Investments in Awardee Companies	
Year	Investment
2008	$18.5 million
2007	$36.7 million
2006	$57.8 million
2005	$43.5 million
2004	$10.6 million

NSF also encourages the Phase II awardees to participate in NSF-wide funding opportunities that stimulate job creation. The Research Experience for Undergraduate Program (REU) is a supplemental opportunity used to support the inclusion of undergraduate students in SBIR projects and expose them to an entrepreneurial small business environment. The Research Assistantship Supplements for High School Students (RAHSS) program offers women and minority students an opportunity to work on scientific and engineering projects to foster interest in pursing science, technology, and engineering studies in college, and the Research Experience for Teachers Program (RET) provides an opportunity for high school teachers and community college professors to work at a small business on projects in order to bring knowledge of engineering and technological innovation into their classrooms. These programs enhance the capabilities of the students/teachers that participate, and reflect NSF's core commitment to education and work force development. These supplemental funding programs have also proven to be excellent sources for future hires for successful small business firms to support their growth.

The NSF SBIR program continually strives to encourage awardees to start early in forming partnerships with strategic partners or investors. We do this in order to leverage the government funding. As we all know, it takes far more than the SBIR investment to move an innovation from the research lab to the market place. As you will see in the examples that follow, several small businesses accomplished this successfully. We believe that these examples illustrate the NSF role in stimulating technological innovation that benefits the US in its global competitiveness.

Innovation through partnerships

An important goal of SBIR at NSF is to move technologies evolving out of scientific and engineering discoveries funded by NSF to the market place. To achieve this, partnerships are critically important. NSF-funded collaborative research centers both spur innovation and provide a fertile synergy between universities and industry. Within the Directorate for Engineering (ENG) at NSF, there are several centers programs including Engineering Research Centers (ERC) and Industry/University Cooperative Research Centers (I/UCRC). Both programs require substantial industry involvement, and SBIR firms can benefit from the expertise and talent of the students and faculty at these centers. We have established programs to help our SBIR awardees leverage industrial and academic talent through membership arrangements with NSF-funded Engineering Research Centers, and Industry/University Cooperative Research Centers, and sixty-four firms have taken advantage of this option.

SBIR/STTR Firms Joining Centers		
	I/UCRC	ERC
FY2007	13	12
FY2008	23	0
FY2009	9	7
Some memberships are longer than one year		

Beyond academic centers, the NSF recognizes the need to help new awardees connect with industrial companies and investors for successful commercialization of their innovative products and services. As noted earlier, for the past ten years, NSF has provided incentives for awardees to form these partnerships by making Phase IIB supplements available. Industrial partners help with the marketing and distribution of the product and even manufacturing, and the venture capitalists or angel investors invest capital to finance continued business development.

Not all grantees on their own will be successful in attracting partners, so the NSF SBIR program launched the MatchMaker program to actively connect awardees with potential partners. For the industrial companies this is a win-win situation since the corporate R&D function now relies heavily on "Open Innovation" whereby large companies aggressively scout external sources for new technologies. The NSF SBIR companies are excellent candidates for such partnerships because the industry executives recognize that the NSF SBIR companies have been scrupulously screened by experienced program managers along with technical and commercial external reviewers at NSF. Occasionally these partnerships become so strong that the large corporation will opt to bring the small company directly into their mainstream operations. Consequently the NSF MatchMaker program not only supports commercialization of the small business' technologies but also uses the energy and innovative capacity of the small entrepreneurial companies in driving the nation's industrial engine.

Acquisitions of NSF-SBIR Firms	
Year	Number acquired
2006	17
2007	19
2008	8

Currently there are about forty industrial companies and twenty venture capitalists and angels currently in the MatchMaker program, seeking technology partnerships and attractive investments. The industries include electronics, communications, information technology, advanced materials, energy, chemicals, paper, food, agriculture, biotechnology and medical devices.

Innovation Success

One measure of a company's success is certainly external recognition, from industry groups, investors, professional organizations, and others. Six of the innovations highlighted in R&D Magazine's R&D 100, came from NSF-funded SBIR firms[1].These firms are representative of the national breadth of our awards, coming from Arizona, California, Connecticut, Florida, Illinois, and Massachusetts. In total, small firms now account for over 25% of the R&D awards given out today, a big change from the same period twenty five years ago when large corporate R&D labs dominated. This is just another indicator of how critical a role small entrepreneurial companies play in the nation's innovation capability.

I would like to highlight two firms to illustrate that in addition to funding great technologies, NSF is keenly interested in the broader impacts of our awards.

Touch Graphics is a small firm in New York City, which has received NSF SBIR awards to develop assistive technologies for visually impaired persons. Touch Graphics was founded in 1998 as a commercialization vehicle for technologies first demonstrated at Baruch College, part of City University of New York. As of 2009, Touch Graphics, Inc. employs seven people. Touch Graphics, Inc. received its first SBIR grant from NSF in 2000 for development of an audio-tactile interactive device known as the Talking Tactile Tablet (TTT). The product was originally conceived as a tool for teaching algebra, trigonometry and calculus to students with limited or no access to print graphics, and has since expanded to broader applications. In 2004, Touch Graphics teamed with another NSF SBIR awardee, Exceptional Teaching, Inc., to bring to market a self-teaching Braille literacy training system known as SAL. The SAL system has become Touch Graphics' big seller, and this has driven general awareness of this new possibility for teaching and learning about materials that usually require access to maps, diagrams, graphs and other illustrations. Over 600 TTT units are in use. The TTT was awarded a Gold Medal in the 2006 IDEA Awards.

[1] R&D Magazine July 2008 (Picarro Inc., Sunnyvale, CA, Advanced Fuel Research, Inc., East Hartford, CT, Materials & Electrochemical Research Corp., Tucson, AZ, Engineering Matters, Inc., Newton, MA, Advanced Diamond Technologies, Romeoville, IL, Sinmat, Inc., Gainesville, FL)

Another area for Touch Graphics that has been supported by NSF SBIR funding is in the world of informal education in Science, Technology, Engineering, and Mathematics (STEM). The company has developed a range of technologies for universally accessible displays and exhibits at science and technology centers, planetaria, and other museums and exhibit spaces. As a direct outcome of this SBIR project, the company is now developing talking touchable models for the National Park Service and the Smithsonian Information Center at the Castle, including a map of the National Mall.

Divergence, Inc. of St. Louis, Missouri is working to develop and market a safer method of preventing crop damage due to parasitic nematodes attacking plant roots. Worldwide the company estimates that parasitic nematodes are responsible for $80 billion in crop damage annually, including significant damage to common US crops such as soybeans. Using Phase II/IIB funds together with funds from Divergence and corporate partner Monsanto Company, Divergence put in place an efficient program for testing biotechnology-based nematode control. Their program evaluates potential nematicidal molecules in a hairy root system rather than in whole plants, saving time, money, and greenhouse space. Several molecules from Divergence's STEM^{TM} plant protein library are currently being tested for their ability to confer nematode resistance. Successful molecules will be tested in whole plants by Monsanto.

I should note that the first applications of this approach to fighting plant parasitic nematodes was led by Divergence founder James McCarter at Washington University and Divergence ,and Divergence's Scientific Advisory Board member David Bird at North Carolina State University, who were both supported by NSF academic funding. Divergence has also received funding from the National Institutes of Health for related work. Technologies like those being developed by Divergence and other NSF-SBIR grantees can assure food security and drive economic growth through agriculture.

The two firms that I have highlighted here are each just single pieces in the broad mosaic of NSF-SBIR firms. A large number of these companies are engaged in the critically important areas of renewable energy, environmental technology and advanced information technology, as may be involved in electronic health records. One notable company is A123 Systems, Inc of Cambridge MA. A123 Systems has developed leading edge lithium-ion battery technology for the next generation hybrid and electric vehicles built in part upon technical breakthroughs by NSF SBIR grantees such as the minority-owned firm T/J Technologies of Ann Arbor, Michigan. A123 Systems has plans for a major electric battery manufacturing plant in Michigan, again demonstrating that small businesses are leading the ways towards new manufacturing industries in the United States.

We have been very conscious of the impacts of our program beyond technical and economic development, to supporting future researchers, engineers, and educators in STEM fields as well. I would like to highlight a few of the programs that we have developed to help nurture the next generation of technically driven innovators.

Job Creation

There are several ways in which NSF SBIR awards contribute to job growth: firms hiring or retaining employees as result of a grant, students and teachers brought in on a temporary basis through an Research Experiences for Undergraduates (REU), Research Experiences for Teachers (RET), or Research Assistance Supplements for High School Students (RAHSS) supplement, and the indirect and secondary effects the firms' purchases of material goods and services. NSF has good estimates of the first two direct impacts, but we do not have a good estimate of secondary effects.

The direct impact of the firms' hiring and retaining employees as the result of an NSF-SBIR award was addressed in a study by the National Research Council[2]. The study found that firms hired an average of 1.5 employees and retained two employees as a result of a Phase II grant. In parallel, NSF engaged in a systematic Phase II Commercialization Study that followed growth of revenues and employment by SBIR companies for eight years starting from the launch of a Phase II research project. A group of 201 8^{th} year projects, representing most (about 85%) of the 8^{th} year companies interviewed, was examined to determine the overall revenue and personnel growth rates. The analysis is complicated by a few confounding factors, such as frequent reorganizations, spin-offs, mergers, etc, and by changing market conditions. However, because of the large number of companies examined, and the length of time involved, the data provides a useful insight into the company growth patterns. The reported growth over the 8 years averaged 21% in revenues and 7% in personnel annually. Since the mean size of the companies under study was roughly 10 people we can estimate that on average each company added almost one person per year, which aligns well with the NRC number of 1.5 people per two-year Phase II award.

Professional development of students through entrepreneurial exposure and research experience is an important part of NSF's SBIR program. Currently, 36 of 475 active grantees are supporting or will be supporting a total of about one hundred students through Research Experience for Undergraduates (REU) supplements. These students typically work ten weeks in the summer and receive an average stipend of $5000. Throughout NSF, REU is a critical program to creating the next generation of STEM professionals, and REU slots are hotly competed for by students.

The Research Assistance Supplements for High School Students (RAHSS) program is designed to foster both opportunity and interest in science and engineering among female and minority high school students. The program provides an opportunity to work on scientific and engineering projects, and we hope fosters these students' interest in pursing science, technology, and engineering studies in college. This program is unique to NSF and three of our Phase II grantees took advantage of it last year.

The Research Experiences for Teachers (RET) program brings high school teachers and community college professors to work at a small business in SBIR-funded research

[2] An Assessment of the SBIR Program at the National Science Foundation, Charles W. Wessner, Ed., The National Academies Press (2007), www.nap.edu

projects. They can then bring their experiences in engineering and technological innovation into their classrooms, and ultimately to their students.

Together these supplement programs enhance the capabilities of these students and teachers, and synergistically develop interest in technical innovation, engineering, and entrepreneurship in the broader community. These supplemental funding programs have also can be excellent sources for future hires as SBIR firms grow.

Concluding Remarks

In conclusion, the NSF SBIR program is uniquely positioned to foster private sector technological innovation and create jobs in small business firms. NSF's mission is very broad and thus is not constrained to focus on developing applications for NSF's own use but to support innovation research that could lead to commercialization and broad societal benefits. In other words, the SBIR program seeks to ensure that innovative technologies and products based on those technologies make it to the marketplace and benefit the American people. We are constantly engaged in assessing our performance against that simple test and the four broad goals of the SBIR program in general.

Madam Chairwoman, this concludes my testimony. On behalf of the National Science Foundation, the SBIR program and our awardees, I want to thank you for this opportunity to highlight a program that provides small businesses with the means to create innovative products and to develop the next generation of innovators. We look forward to working with Congress to strengthen America's small businesses and helping them develop and commercialize innovative processes and products to sustain our national economy. I would be pleased to provide any additional information that would be useful to you.

Supplements Available to NSF-SBIR Awardees

Supplement Name	Goal of Supplement	Additional Dollar Amount (from NSF)	Grant Performance Period Extended	Latest Date to Submit	Special Requirements
Phase IB	Bridge the gap between Phase I and Phase II funding while at the same time encouraging partnering as a means to increase the potential for SBIR/STTR grantees to successfully commercialize their technology http://www.nsf.gov/eng/iip/sbir/ibinstructions.jsp	$50,000.00	6 months	Deadline (April 15 & October 15)	Must be an active grantee
Phase IIA	Foster partnerships between the academic and small business communities; increase participation of underrepresented groups in both academic and small business research; and encourage members of underrepresented groups to pursue careers in science and engineering. http://www.nsf.gov/pubs/2006/nsf06004/nsf06004.jsp	$150,000.00 With 70% to CREST/ HBCU	up to 2 years		Centers of Research Excellence in Science and Technology (CREST) CREST and/or HBCU as partners
Phase IIB	Bridges the gap in funding between Phase II and Phase III; extends the R&D efforts beyond a current grant to meet the product/process/software requirements of a third party investor to accelerate the Phase II project to the commercialization stage and/or enhance the overall strength of the commercial potential of the Phase II project. http://www.nsf.gov/eng/iip/sbir/phase_iib.jsp	$500,000.00	up to 2 years	60 days prior to expiration	Must be submitted during the original 24 month period of the Phase II award; need permission from PD to submit. For STTR Phase IIB applications the required partnering percentages applies.

Supplements Available to NSF-SBIR Awardees

Phase IIR	Research that is mutually beneficial to the ERC and the SBIR/STTR grantee and thus it will serve the following dual purposes: (1) to speed the transition of ERC-generated research and technology advances to the market place and engage ERC students more directly in the innovation process, and (2) to strengthen the research capacity of the SBIR/STTR grantee and broaden its portfolio of marketable products. http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07035	$200,000.00		Inactive
Phase IICC	Foster partnership between Minority-Serving Community Colleges (MSCCs), which educate large numbers of underrepresented students, and the small business community. NSF is seeking to increase the participation of underrepresented groups in both academic and small business research by encouraging careers in science and engineering. These supplements are in collaboration with EHR. http://www.nsf.gov/pubs/2006/nsf06008/nsf06008.jsp	$40,000.00 With 40% to the CC	at least 6 months from expiration	

Supplements Available to NSF-SBIR Awardees

Phase II M	Intended to broaden participation and to increase the diversity of small businesses within the NSF SBIR/STTR program. The supplements will enable small businesses to be mentored by existing NSF SBIR/STTR grantees by leveraging the NSF SBIR/STTR program knowledge with non-NSF SBIR/STTR companies. The mentors will guide the mentored small businesses through the proposal life cycle process, which covers the development, submission and potential award of a proposal. http://www.nsf.gov/pubs/2009/nsf09004/nsf09004.jsp?org=IIP	up to $50,000	2 years	no limit	Proven Track record of successful bringing products or services to market.
REU	Supports active research participation by undergraduate students; students must be citizens or permanent residents of the United States or its possessions http://www.nsf.gov/eng/iip/sbir/Supplement/REU.jsp	$12,000.00	no	at least 6 months from expiration	$6,000 per student (up to 2 students per year) 25% of the $6,000 can be used for an administrative allowance (in lieu of indirect costs)
RET	Supports the active involvement of K-12 teachers and community college faculty in engineering research in order to bring knowledge of engineering and technological innovation into their classrooms. http://www.nsf.gov/pubs/2003/nsf03554/nsf03554.htm	$20,000.00	no	at least 6 months from expiration	$10,000 per teacher (up to 2 teachers per year); $1,000 stipend for materials, equipment, software, and other supplies for developing classroom instruction; 25% of the $10,000 can be used for an administrative allowance (in lieu of indirect costs)

Supplements Available to NSF-SBIR Awardees

RAHSS	Research Assistantship Supplements for High School Students (RA) supports active research participation by high schools students in the SBIR/STTR Program. This opportunity broadens the participation of women and minority students in academic and small business research to foster interest in pursuing science, technology, and engineering studies at the college level. http://www.nsf.gov/eng/iip/sbir/Supplement/RAHSS.jsp	$12,000.00	no	at least 6 months from expiration	High School Students (women, under-represented minorities, and persons with disabilities); $6,000 per student (up to 2 students per year) 25% of the $6,000 can be used for an administrative allowance (in lieu of indirect costs)
I/UCRC Membership	Aims to accelerate the innovation process by partnering industry-relevant academic research with commercialization focused small business research. It is designed to open the doors for small businesses to the benefits from the collaborative research performed at Industry/University Cooperative Research Centers (I/UCRCs) http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08066	$50,000.00	no	for active Phase II within 60 days of expiration date; for non active the supplement is submitted directly to the Center	Enables NSF SBIR/STTR grantee firms to purchase one or two year memberships in an I/UCRC